2 2-28-02

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Signed J Evans.

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1.	Your reference	GB920000110GB1
		05DEC00 E588703-1 D00611 P01/7700 0.00-0029504.8
2.	**0029504.8**	1 DEC 2000
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	INTERNATIONAL BUSINESS MACHINES CORPORATION Armonk New York 10504 United States of America
	Patents ADP number *(if you know it)*	5196370001
	If the applicant is a corporate body, give the country/state of its incorporation	State of New York United States of America
4.	Title of the invention	A TOOL FOR REWORKING A PRESS-FIT CONNECTOR
5.	Name of your agent *(if you have one)*	G M Zerbi
	"Address for Service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	IBM United Kingdom Limited Intellectual Property Department Hursley Park Winchester Hampshire SO21 2JN
	Patents ADP number *(if you know it)*	7113038001

6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority App No *(if you know it)*	Date of filing *(day/month/year)*

7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	No of earlier application	Date of filing *(day/month/year)*

Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is nat an inventor, or
b) there is an inventar who is not named as an applicant, or
c) any named applicant is a carparate bady.)

Yes

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	9
Claim(s)	2
Abstract	1
Drawing(s)	6 x6

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Farm 7/77)*	3 ✓
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application

Signature — 30 November 2000 Date

12. Name and daytime telephone number of person to contact in the United Kingdom

G M Zerbi
01962 815229

A TOOL FOR REWORKING A PRESS-FIT CONNECTOR

The present invention relates to a tool for reworking a press-fit connector.

Connectors are commonly used for joining together electronic assemblies, such as Printed Circuit Boards (PCBs). A particular type of connector is formed by several wafer modules arranged side by side; each module has a plurality of conductive pins, which are press-fitted into corresponding plated holes of the board. A connector of this type is for example manufactured by Teradyne Inc. with the name of VHDM (VHDM is a trademark of Taradyne Inc.).

The modules of the connector are easier to build with the necessary tolerances than a single large connector. Moreover, each module can be individually removed from the board for maintenance operations. As instance, the pins may bend during mounting of the connector on the board, when the pins are fitted into the holes by means of a press machine. Therefore, the bent pins are not inserted into the holes and the corresponding faulty module of the connector must be replaced.

A know solution for reworking the connector consists in removing the faulty module from the board by means of pliers hand-driven by an operator. The operator inserts each jaw of the pliers from the top between the faulty module and the respective adjacent module; the jaws are then closed onto the faulty module, thereby grasping the same, and the faulty module is pulled out the board.

A drawback of this solution is that the operation of removing the faulty module may warp the two adjacent modules, which must be replaced as well. Moreover, the uncontrolled movement of the operator hand may damage the holes of the board. In this case, if the damage to the holes does not cause an electrical failure immediately detectable, the board is prone to suffer a fault later on; this involves a very high cost for replacing the board already installed, for example in a computer.

These drawbacks are particularly acute when some means of engagement between adjacent modules, such as lateral wings, are provided. In this situation, it was also proposed to insert a shim between the faulty module and each adjacent module, in order to separate and unlock the modules.

However, the insertion of the shims is not an easy operation; moreover, the shims increase the risk of damaging the adjacent modules and the board.

It is an object of the present invention to overcome the above mentioned drawbacks. In order to achieve this object, a tool for reworking a press-fit connector as set out in the first claim is proposed.

Briefly, the present invention provides a tool for reworking a press-fit connector attached to an electronic board and having a plurality of stacked wafer modules, the tool including a first and a second jaw for grasping and removing a selected one of the modules from the board, holding means for holding the board and means for moving the jaws relative to the holding means, at least one of the jaws having means for separating each module adjacent to the selected module from the selected module.

Further features and the advantages of the solution according to the present invention will be made clear by the following description of a preferred embodiment thereof, given purely by way of a non-restrictive indication, with reference to the attached figures, in which:

Fig.1 is an exploded view of an electronic assembly on which the tool of the invention can be used,

Fig.2a shows the tool in perspective,

Fig.2b is a schematic front view of the tool,

Fig.2c depicts a jaw of the tool,

Fig.3 illustrates a frame of the tool,

Fig.4 shows the action of the jaw on the connector.

With reference in particular to Fig. 1, there is shown an electronic assembly 100. The assembly 100 is formed by a printed circuit board 105 (consisting of an insulating substrate with one or more layers of conductive tracks), on which several electronic devices (not shown in the figure) are mounted. The board 105 has two insertion holes 110 (only one shown in the figure), which are arranged at opposed corners thereof.

An upper surface of the board 105 is provided with guide pins 115 and power sockets 120. A matrix of plated through-holes is formed in the board 105. The matrix consists of columns with six holes 125s (for transmitting electrical signals) and columns with five holes 125g (connected to a reference terminal, or ground); the columns of ground holes 125g are arranged (in a staggered manner) between each column of signal holes 125s. The guide pins 115, the power sockets 120 and the matrix of holes 125s,125g are aligned along a front edge of the board 105.

A female press-fit connector 130 is attached to the board 105. The connector 130 consists of a stack of modules which are arranged side by side; particularly, the connector 130 includes one or more guidance modules 135, one or more power modules 140 and several wafer modules 145 (typically in multiple of 10 or 25).

Each wafer module 145 consists of an insulating body 150 made of plastic material. The insulating body 150 holds a column with six signal pins 155s and a parallel column with five ground pins 155g, for insertion into a corresponding column of signal holes 125s and a corresponding column of ground holes 125g, respectively. The ground pins 155g are staggered with respect to the signal pins 155s; each pin 155s,155g extends downwards from the insulating body 150 and consists of a metal blade with a compliant structure (defined by a respective central hole).

Six receptacles 160 for insertion of mating pins of a male connector (not shown in the figure) are arranged on a front edge of the insulating body 150. Each receptacle 160 houses a conductive fork 165 (provided on a front side of the module 145), which is connected to a respective signal pin 155s; the forks 165 and the signal pins 155s extend at right angle. Each fork 165 is formed by a pair of opposed cantilever beams, which act as a spring exerting an anti-stubbing pressure on the inserted pin of the male connector. A ground plane 170 is provided on a rear side of the module 145; the ground plane 170 is connected to all the ground pins 155g. In this way, each row of signal pins 155s is sandwiched between two adjacent ground planes 170, which define a stripline shielding reducing undesirable interactions between adjacent columns of signals pins 155s.

The front side of the module 145 features several horizontal channels 175 formed by corresponding ribs provided on the insulating body 150. The insulating body 150 further includes four alignment pins 180 and two wings 181 extending backwards (through respective openings of the ground plane

170 as far as the alignment pins 180 are concerned); the wings 181 are used to increase the electrical contact between the ground plane 170 and a corresponding ground plane of the male connector. The alignment pins 180 engage corresponding channels 175 of a previous module, whereas the wings 181 engage corresponding seats 183 formed in the front surface of the previous module between adjacent forks 165. A stiffener 185 is stamped from a strip of metal, which is then bent at right angle. The stiffener 185 includes holes mating corresponding locking tabs 190 provided at the top of each module 135, 140 and 150.

The connector 130 is assembled stacking side by side the modules 135, 140 and 150. The alignment pins 180 and the wings 181 engage the respective channels 175 and seats 183, thereby positioning the modules of the connector 130; particularly, the interference between these elements prevents each module from slipping off the stack along a direction perpendicular to a longitudinal axis thereof. The stiffener 185 is fitted on the modules 135, 140 and 145; the stiffener 185 holds together the modules and increases strength and rigidity of the connector 130.

The connector 130 is press-fitted on the front edge of the board 105. Each guidance module 135 is provided with a hole, which is coupled to the corresponding guide pin 115 for controlling the mounting of the connector 130. The power modules 140 are joined to the corresponding power sockets 120; at the same time, the signal pins 155s and the ground pins 155g of each module 145 are inserted into the corresponding signal holes 125s and ground holes 125g, respectively, and are held therein by friction.

The connector 130 is used as an edge mounted connector. For example, the board 105 is a daughterboard and the connector 130 is used to mate the board 105 to a backplane assembly (wherein a corresponding male connector is provided), or the board 105 is an extender card and the connector 130 is used to mate the board 105 to another board.

Likewise considerations apply if the board and the connector have a different structure, for example if the connector is of a top-side type, if the connector has no guide modules and/or power modules, if the connector includes a different number of wafer modules, if the connector is of the male type, if the pins and the forks are replaced by equivalent contacts, if the connector is un-shielded, if each row consists of a different number of pins (for example eight), if there is no means of engagement between adjacent modules, and so on.

With reference now to Figg.2a and 2b, there is shown a tool 200 for reworking the connector 130, and in particular for removing a selected module (for example a faulty module) from the board 105. The tool 200 includes a frame 205, which is used to hold the board 105 (as described in detail in the following).

A rail 210 for a slide 215 is integral with the frame 205. The slide 215 includes two independent bases 220a and 220b. A locking screw 225 (ending with an upper knob) is inserted into a corresponding vertical threaded through-hole of the base 220a; the locking screw 225 is used to avoid sliding of the base 220a along the rail 210. The base 220b is connected to the base 220a by means of a right-and-left regulating screw 230 (provided with a central knurling disc), which is inserted into facing horizontal threaded holes of the bases 220a and 220b.

The base 220b features a cantilever portion bridging the edge of the board 105 on which the connector 130 is mounted. A head 235 has two vertical through-holes, which are inserted into respective guide pins projecting upwards from the cantilever portion of the base 220b. The head 235 is moved up and down by means of a pulling screw 240 (ending with an upper knob), which is inserted into a corresponding vertical threaded through-hole of the head 235.

The head 235 carries two opposed arms 245a and 245b. Particularly, a central threaded pin and two lateral guide pins extend horizontally from a right side of the head 235. The arm 245a has three horizontal through-holes for the corresponding pins of the head 235; a spring associated with the central pin (not shown in the figure) biases the arm 245a away from the right side of the head 235. A knurling handle 260a is screwed onto the central pin and it is used to move the arm 245a to the right and to the left. In a similar manner, the arm 245b is moved to the right and to the left by means of a knurling disc 260b (see Fig.2b). A set screw 265 is inserted into a respective horizontal threaded through-hole of the arm 245a; the set screw 265 is used to regulate a stop position of the arm 245a. A similar structure (not shown in the figure) is used to regulate the stop position of the arm 245b and of the head 235.

The head 235 includes a vertical guide 270 arranged between the arms 245a and 245b; the guide 270 consists of an elongated element having a U-shaped cross-section (closed at the top) and a front plate fixed to the elongated element by means of two screws 275a and 275b. A pressing element

280 slides inside the guide 270; the pressing element 280 has a vertical slit 281 for accommodating the faulty module removed from the board 105. As shown in Fig.2b, the pressing element 280 is moved up and down by means of a positioning screw 283 (ending with an upper knurling knob). The positioning screw 283 passes through a top side of the guide 270, wherein it is hold by two collars; a lower end of the positioning screw 283 is inserted into a vertical threaded hole of the pressing element 280.

A jaw 284a is fixed on a front side of the arm 245a by means of a screw 285a; in a similar manner, a jaw 284b is fixed on a front side of the arm 245b by means of a screw 285b. The jaw 284b ends with two hooks 287a and 287b for engaging corresponding lateral projections of the faulty module 145. The jaw 284a has a vertical slit 290 for receiving an external lateral edge of the faulty module 145; the slit 290 is closed by a bottom surface 290b, in order to define a hook for engaging the faulty module 145. As shown in Fig.2c, the jaw 284a is wedge-shaped. Particularly, the slit 290 is arranged between two inclined surfaces 295a and 295b (with respect to the faulty module). The inclined surfaces 295a and 295b define an angle preferably in the range between 25°-40°.

With reference now to Fig.3, the frame 205 consists of a side-member 305a (fastened to the rail 210) and a parallel side-member 305b; two cross-pieces 310a and 310b extend perpendicularly between the side-members 305a,305b. Each cross-piece 310a,310b ends with two opposed eyes for sliding along the respective side-members 305a and 305b. A locking screw 315a and 315b is used to keep the cross-piece 310a and 310b, respectively, in a selected position. The cross-pieces 310a,310b have a telescopic structure; the length of each cross-piece 310a and 310b is regulated by means of a screw 320a and 320b, respectively.

Two reference threaded pins 325a and 325b (for the insertion holes 110 of the board 105) extend upwards near a front end of the cross-piece 310a and a rear end of the cross-piece 310b, respectively. A nut 330a (for the reference pin 325a) and a nut 330b (for the reference pin 325b) are used to hold the board 105.

Each time the connector must be reworked, the frame 205 is regulated according to the dimension of the board 105. Particularly, the locking screws 315a,315b are loosened, and the cross-pieces 310a,310b are moved to the right or to the left until their distance fits the length of the board 105; the locking screws 315a,315b are then tightened. Similarly, the

regulating screws 320a,320a are loosened, and the cross-pieces 310a,310b are extended or shortened until their length fits the width of the board 105; the regulating screws 320a,320b are then tightened. The board 105 is placed onto the frame 205, and the reference pins 325a,325b are fitted into the insertion holes 110. The board 105 is then secured by screwing the nuts 330a,330b onto the reference pins 325a,325b.

The stiffener is removed from the connector 130 in a known manner. The slide 215 (Fig.2a) is moved horizontally (with the head 235 in a raised position and the jaws 284a,284b in an open position) until the jaws 284a,284b are roughly positioned over the faulty module to be removed. The base 220a is locked by tightening the locking screw 225. The base 220b is then finely positioned by acting on the regulating screw 230.

The pressing element 280 is lowered by loosening the positioning screw 283, until it abuts against the connector 130. In a similar manner, the head 235 is lowered by loosening the screw 240, until the jaws 284a,284b face the corresponding lateral edges of the faulty module; the stop position of the head 235 (defined by abutment of the corresponding set screw against a top surface of the cantilever portion of the base 220b) prevents the jaw 284a from touching the board 105.

The jaws 284a and 284b are then closed on the faulty module individually; in particular, the arm 245a carrying the jaw 284a is moved to the left (by tightening the knurling handle 260a), and the arm 245b carrying the jaw 240b is moved to the right (by tightening the knurling disc 260b), until the jaws 284a,284b abut against the corresponding lateral edges of the faulty module; the stop position of the arms 245a and 245b (defined by abutment of the respective set screws against the corresponding lateral surfaces of the head 235) prevents the jaws 284a,284b from damaging the connector 130.

As shown in Fig.4, the faulty module 145 is inserted into the slit 290. At the same time, the inclined surfaces 295a,295b exert a pressure on the corresponding lateral edge of the adjacent modules. In this way, the adjacent modules are separated from the faulty module; particularly, the alignment pins 180 and the wings 181 are disengaged from the respective channels and seats.

The head 235 (Figg.2a and 2b) is raised by tightening the screw 240. In this way, the faulty module 145 is pulled out the board 105 sliding

along the slit 281, while the adjacent modules are kept in position by the pressing element 280. The jaws 284a and 284b are opened by loosening the knurling handle 260a and the knurling disc 260b, respectively. The removed faulty module is then slipped off the slit 281 and scrapped. The pins of a new module are seated into the corresponding holes of the board 105, and the new module is pressed by means of a plastic hammer until all modules of the connector are flush; the stiffener is reinstalled and the board 105 is removed from the tool.

Similar considerations apply if the jaws are moved in a different manner, if the jaws have a different structure (for example if both of them are wedge-shaped), if the tool includes other elements (for example a stop arranged between the jaws for regulating their distance in the close position), and the like.

More generally, the present invention provides a tool used for reworking a press-fit connector attached to an electronic board and having a plurality of stacked wafer modules. The tool includes a first and a second jaw for grasping and removing a selected one of the modules from the board, holding means for holding the board and means for moving the jaws relative to the holding means; at least one of the jaws has means for separating each module adjacent to the selected module from the selected module.

The solution of the invention provides a controlled movement of the jaws; as a consequence, the faulty module can be extracted without any damage to the adjacent modules and to the board.

The double effect of the jaw, which grasps the faulty module and separates the adjacent modules at the same time, unlocks the faulty module from the adjacent modules; this result is obtained in a very efficient manner, without requiring any shim. The solution according to the present invention is particularly advantageous when some means of engagement between adjacent modules are provided (even if the use of the tool for a different connector is not excluded).

The preferred embodiment of the present invention described above offers further advantages. Particularly, the wedge-shaped jaw (with the inclined surfaces) and the means used to move the jaws between the open and the close position along a direction parallel to the faulty module provide

a very efficient structure; this result is obtained in a simple and cost effective manner.

The elements used for moving the jaws (such as the slide and the rail) make the tool very easy to use. In addition, the provision of two bases for the slide allows the position of the jaws to be regulated in a very accurate manner.

Moreover, the pressing element guarantees that the removal of the faulty module does not affect the adjacent modules of the connector; this further increases the reliability of the tool.

The jaws are individually removable from the tool (by acting on the respective screws); similarly, the pressing element can be removed by unscrewing the front plate of the corresponding guide. In this way, the tool may be used on different type of connectors simply replacing the jaws and the pressing element. Moreover, the frame can be adjusted according to the dimension of the board, so that the tool can be used to rework connectors included in any type of electronic assembly.

Likewise considerations apply if the jaws have a different structure (for example with separating blades, or other equivalent means), if the jaws are moved relative to the frame in a different manner (for example by means of a cogwheel, or other driving means), if the pressing element consists of two distinct blocks (or other equivalent means), if the jaws and the pressing element are snap-fitted onto the slide; alternatively, the frame may only be regulated in a few pre-set positions, the board is clamped onto the frame, or different means for holding the board are provided.

However, the solution of the present invention leads itself to be carried out even with a slide consisting of a single element, without any pressing element, with the jaws and the pressing element not removable from the slide, or with a frame of fixed dimensions.

Naturally, in order to satisfy local and specific requirements, a person skilled in the art may apply to the solution described above many modifications and alterations all of which, however, are included within the scope of protection of the invention as defined by the following claims.

CLAIMS

1. A tool (200) for reworking a press-fit connector (130) attached to an electronic board (105) and having a plurality of stacked wafer modules (145), the tool including a first (284a) and a second (284b) jaw for grasping and removing a selected one of the modules from the board,

characterised in that

the tool further includes holding means (205) for holding the board and means (210,215) for moving the jaws relative to the holding means, at least one (284a) of the jaws having means (295a,295b) for separating each module adjacent to the selected module from the selected module.

2. The tool (200) according to claim 1, further including first driving means (260a,260b) for moving the jaws (284a,284b) between an open position and a close position along a direction parallel to the selected module (145), the first and the second jaw in the close position abutting against corresponding lateral edges of the selected module extending perpendicularly from the board, and wherein the at least one jaw (284a) is wedge-shaped with a first (295a) and a second (295b) inclined surface for acting on the corresponding lateral edge of the adjacent module in the close position.

3. The tool (200) according to claim 2, wherein the at least one jaw (284a) further includes a slit (290) arranged between the first (295a) and the second (295b) inclined surface for receiving the corresponding lateral edge of the selected module (145), the slit having a closed end (290b) defining a first hook for pulling the selected module (145) out the board (105).

4. The tool (200) according to claim 3, wherein the at least one jaw is the first jaw (284a), the second jaw (284b) ending with at least one second hook (287a,287b) for pulling the selected module (145) out the board (105).

5. The tool (200) according to any claim from 2 to 4, wherein the connector (130) has a longitudinal axis perpendicular to each module (145), the tool further including second driving means (240) for moving the jaws (284a,284b) along a direction perpendicular to the board (105) between a rest position and a working position wherein the selected module (145) is interposed between the first and the second jaw, and third driving means (210,220a,220b,225) for moving the jaws along a direction parallel to the longitudinal axis.

6. The tool (200) according to claim 5, wherein the third driving means (210,220a,220b,225,230) includes a slide (220a,220b,230) carrying the jaws (284a,284), the first driving means (260a,260b) and the second driving means (240), a rail (210) for the slide integral with the holding means (205), and locking means (225) for locking the slide in a selected position along the rail.

7. The tool (200) according to claim 6, wherein the slide (220a,220b,230) includes a first base (220a), the locking means (225) preventing sliding of the first base along the rail (210), a second base (220b) carrying the jaws (284a,284), the first driving means (260a,260b) and the second driving means (240), and means (230) for regulating the position of the second base relative to the first base.

8. The tool (200) according to any claim from 1 to 7, further including pressing means (280) for preventing removal of the adjacent modules (145) from the board (105).

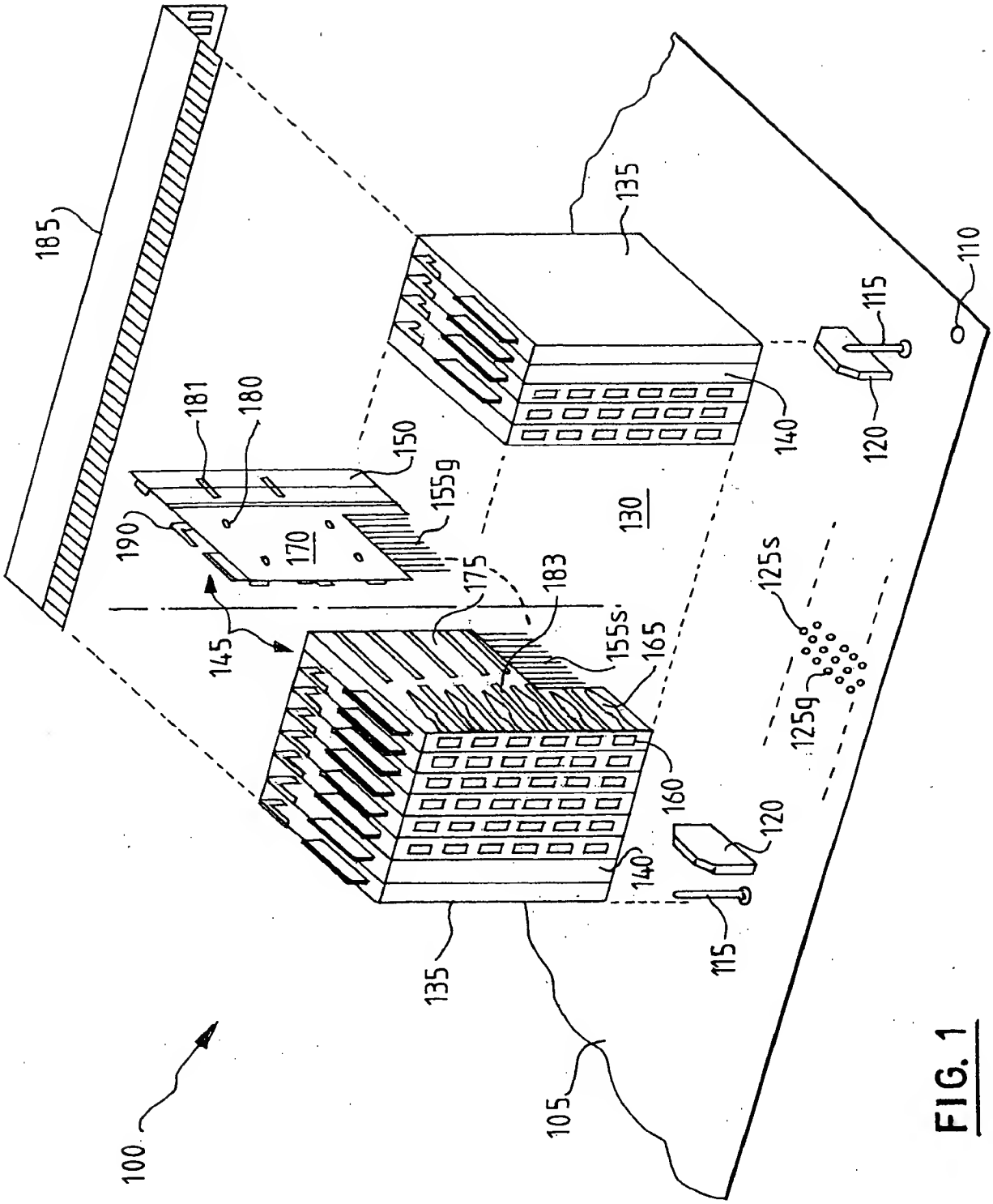
9. The tool (200) according to claim 8, further including means (255a,255b) for mounting the jaws (284a,284b) and the pressing means (280) on the slide (220b) in a removable manner.

10. The tool (200) according to any claim from 1 to 9, further including means (315a,315b,320a,320b) for regulating the holding means (205) according to the dimension of the board (105).

ABSTRACT

A TOOL FOR REWORKING A PRESS-FIT CONNECTOR

A tool (200) for reworking a press-fit connector (130) attached to an electronic board (105) and having a plurality of stacked wafer modules (145), the tool including a first (284a) and a second (284b) jaw for grasping and removing a selected one of the modules from the board, holding means (205) for holding the board and means (210,215) for moving the jaws relative to the holding means, at least one (284a) of the jaws having means (295a,295b) for separating each module adjacent to the selected module from the selected module.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140
120
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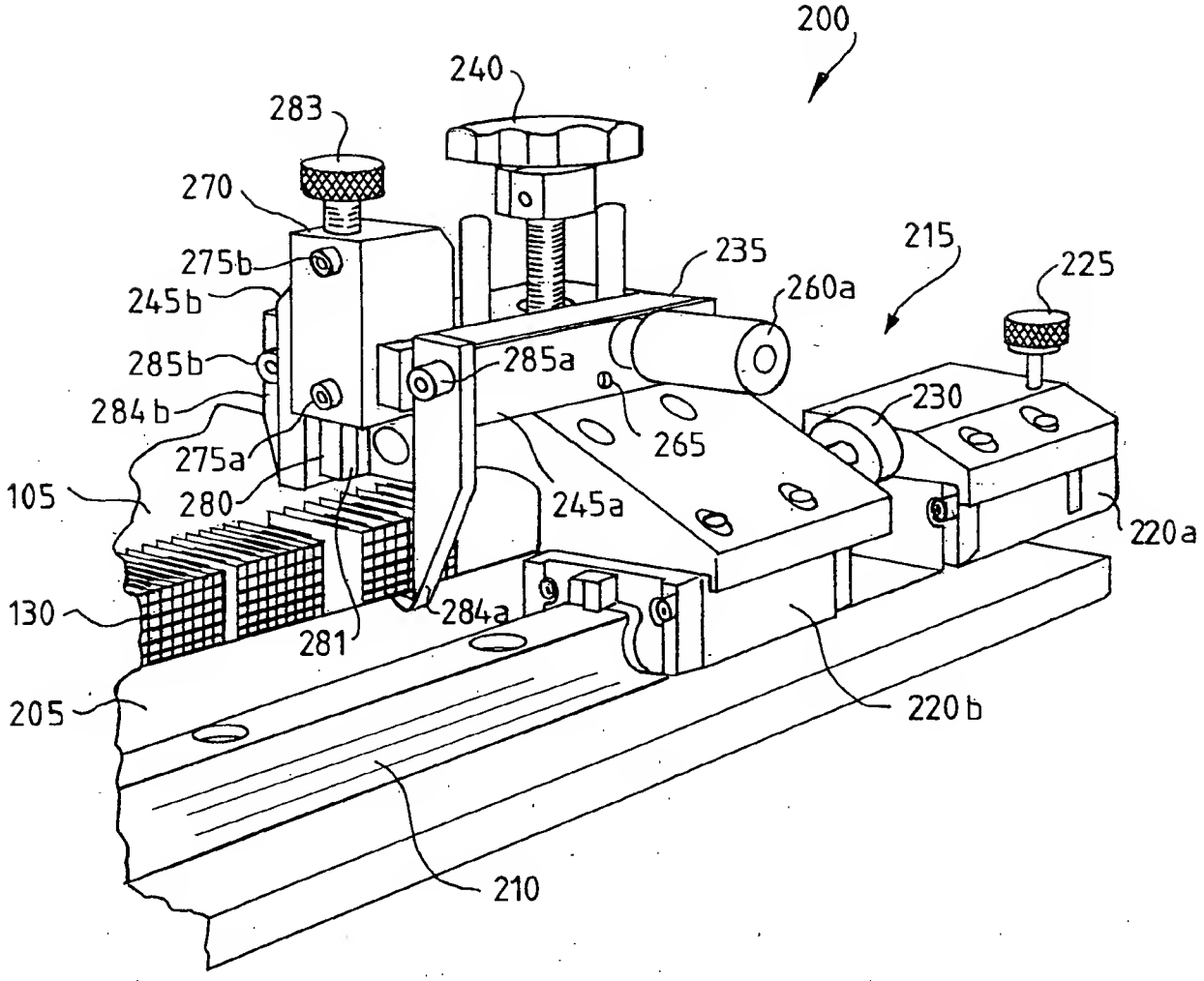
160
120
140
115
135
105
100

FIG. 1


200
240
283
270
275b
245b
285b
284b
275a
105
280
130
281
205
284a
235
215
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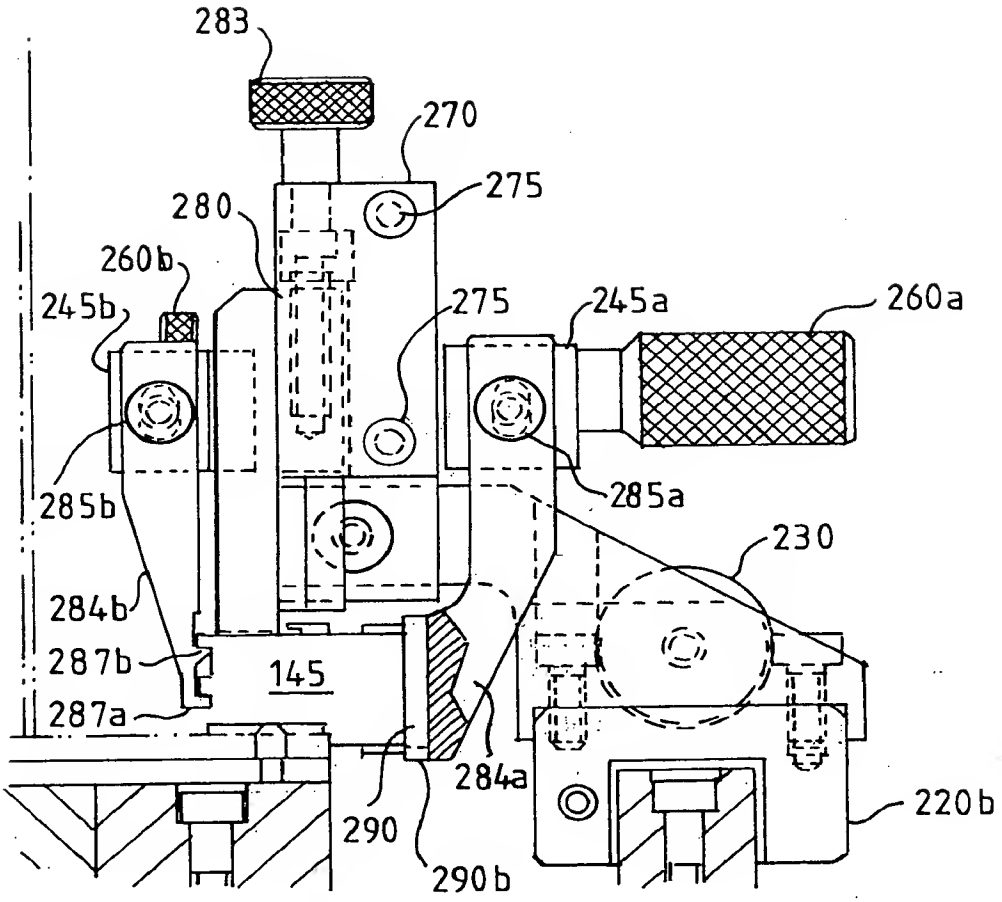
285a
265
230
245a
220a
220b
210

FIG. 2a


283
270
275
280
260b
245b
275
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230
284b
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145
287a
284a
220b
290
290b

FIG. 2 b

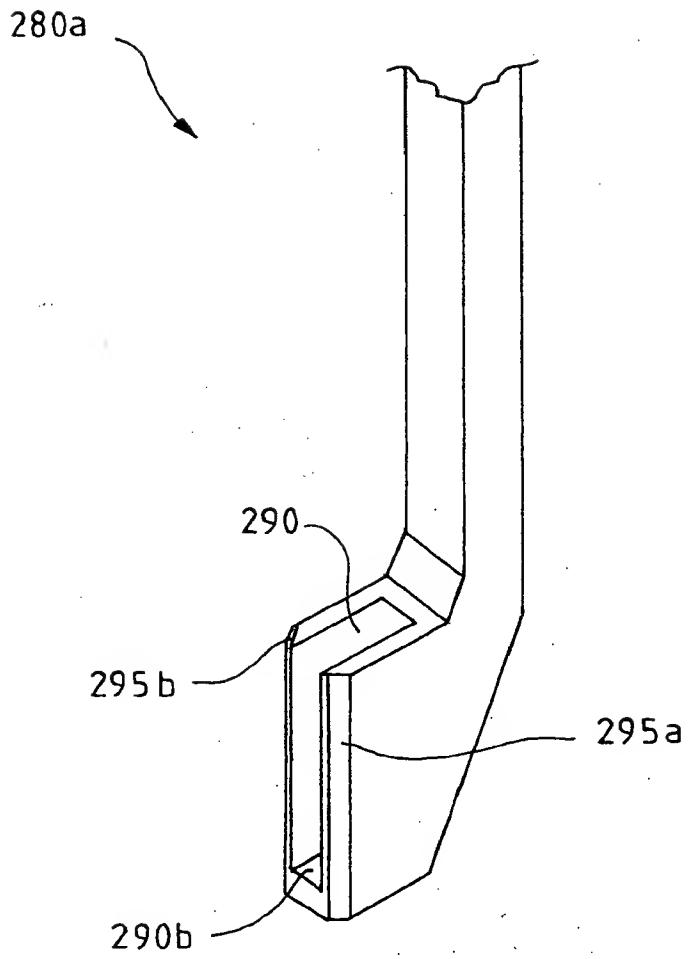
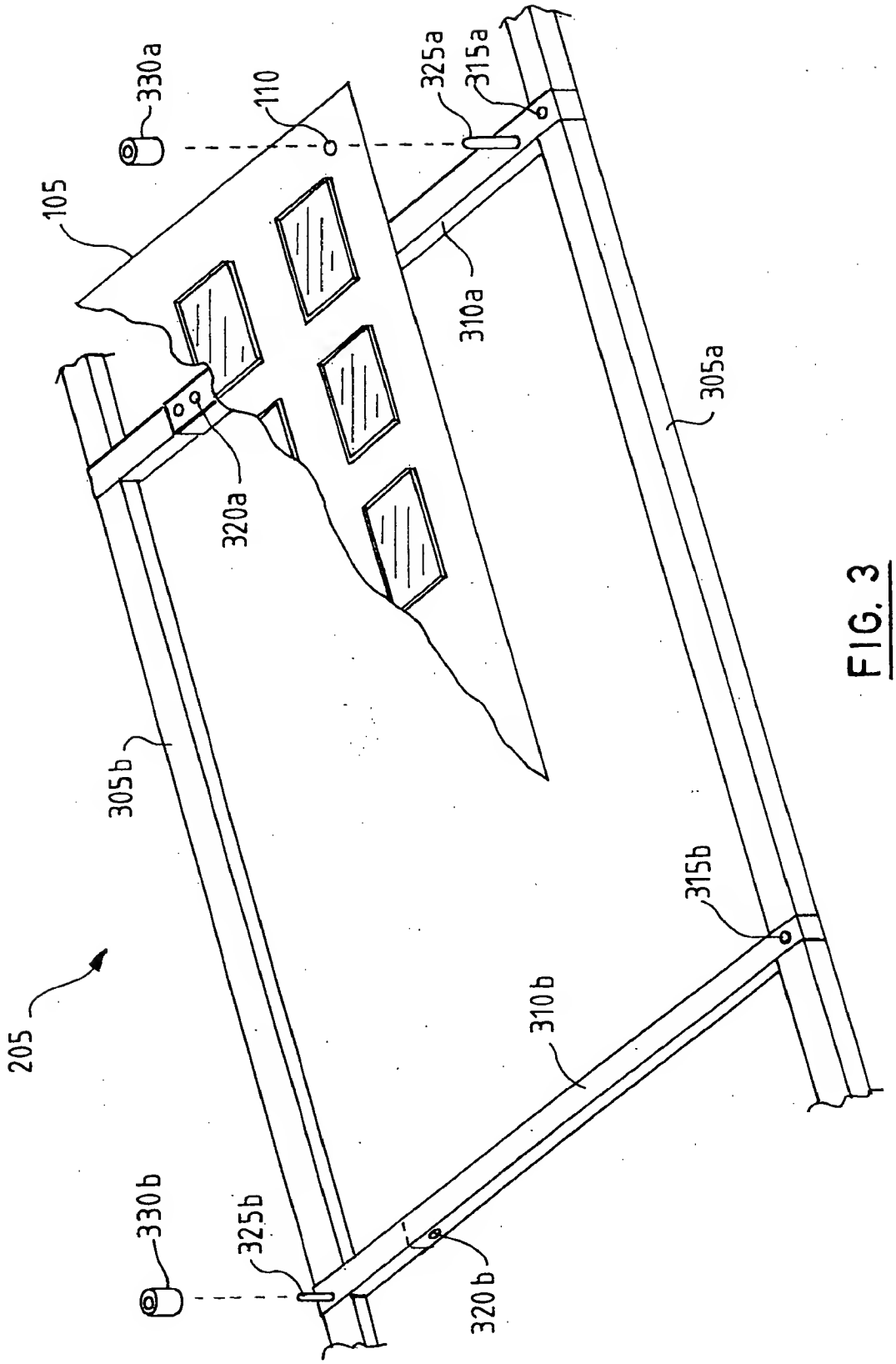


FIG. 2c


330a
110
325a
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105
310a
305a
320a
305b
315b
205
310b
330b
325b
320b

FIG. 3

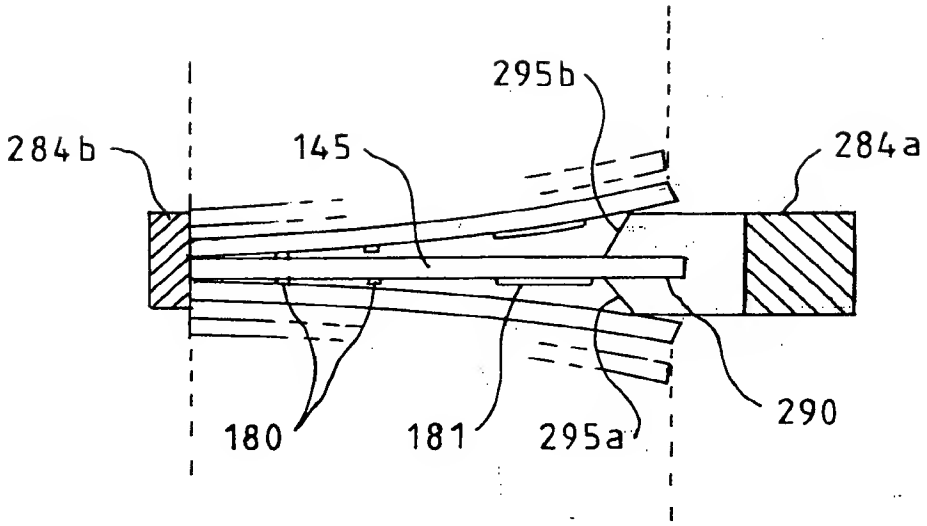

FIG. 4